Claims

[c1] A method, electrical circuit or apparatus for supplying both positive and negative gate drive power supplies to the "top" semiconductor switch, in a typical half-bridge semiconductor power topology, from the gate drive power supplies of the "bottom" switch and without the use of transformer, capacitive or optical isolation and where the half-bridge circuit topology is, only for the purpose of facilitating a concise description of the invention, defined as two insulated gate bipolar transistor (IGBT) switching devices each with anti-parallel diodes and connected in series where the emitter of the "bottom" IGBT is connected to an arbitrary ground reference point, and where the collector of the bottom IGBT, the emitter of the top IGBT and one end of a filter inductor make a common connection and where the other end of said filter inductor is connected to one end of a load and where the other end of said load is connected to a positive DC power source with respect to said ground reference point and where the positive terminal of said positive DC power source is also connected to the negative terminal of a second DC power source having a positive terminal connected to the collector of said top IGBT and where the invention essentially comprises;

a bipolar arrangement of positive and negative power supplies with respect to the bottom IGBT emitter,

a bottom gate driver circuit, capable of driving the gate of the bottom IGBT with respect to the bottom IGBT emitter, to turn the bottom IGBT "on" or "off",

a top gate driver circuit, capable of driving the gate of the top IGBT positive or negative with respect to the top IGBT emitter, to turn the top IGBT "on" or "off",

a bipolar arrangement of positive and negative energy storage

capacitors, with respect to the emitter of the top IGBT, to supply power to said top gate driver circuit,

a diode with anode connected to the positive terminal of said positive power supply referenced to the emitter of said bottom IGBT and with cathode connected to the positive terminal of said positive energy storage capacitor referenced to the emitter of said top IGBT,

a third gate driver, which is substantially synchronized with said bottom gate driver circuit,

a third switching device, a field effect transistor (FET), driven by said third gate driver and with source connected to the negative power supply terminal of said negative power supply referenced to the emitter of said bottom IGBT and with drain connected to the negative terminal of said negative energy storage capacitor referenced to the emitter of said top IGBT and

where the switching action of the half-bridge IGBTs in substantially typical applications using substantially typical control methods plus the described inclusion and timing of said third switching device cause energy in said positive and negative power supplies referenced to the bottom IGBT emitter to be transferred to said positive and negative energy storage capacitors referenced to the emitter of the top IGBT, respectively.

[c2] A method, electrical circuit or apparatus according to Claim 1 further comprising the addition of a diode connected with cathode to the drain terminal of said third switching device and with anode connected to the negative terminal of said negative energy storage capacitor referenced to the emitter of said top IGBT.

[c3] A method, electrical circuit or apparatus according to Claims 1 or 2 where said

third switching device, is brought into conduction when the emitter to collector voltage of said bottom IGBT is determined, by any known typical means, to be substantially less than the highest expected bottom IGBT saturation voltage or the highest expected voltage when the bottom IGBT is substantially in conduction.

[c4] A method, electrical circuit or apparatus according to Claim 1 or 2 where said third switching device, is brought into conduction when sufficient current is sensed, by any known typical means, in a direction indicating that the bottom IGBT is in forward conduction.

[c5] A method, electrical circuit or apparatus according to Claims 1 or 2 where said third switching device, is brought into conduction when the anode to cathode voltage of said anti-parallel diode associated with said bottom IGBT is determined, by any known typical means, to be substantially negative with respect to the emitter of said bottom IGBT, indicating that said anti-parallel diode is in conduction.

[c6] A method, electrical circuit or apparatus according to Claims 1 or 2 where said third switching device, is brought into conduction when sufficient current is sensed, by any known typical means, in a direction indicating that the bottom IGBT anti-parallel diode is in forward conduction.

[c7] A method, electrical circuit or apparatus according to Claims 1, 2, 3, 4, 5 or 6 where the IGBT devices and FET devices are all interchangeable with any mix of semiconductor device types having substantially similar characteristics enough to enable the intended function of the circuit disclosed in Claims 1, 2, 3, 4, 5 or 6.

[c8] A circuit, power converter or motor drive according to Claims 1, 2, 3, 4, 5, 6 or 7 that includes one or more half-bridge circuit topologies.

[c9] A circuit, integrated circuit or circuit module that is substantially designed according to or that substantially functions according to Claims 1, 2, 3, 4, 5, 6, 7 or 8.

[c10] A method, electrical circuit or apparatus according to Claims 1, 2, 3, 4, 5 or 6 where the IGBT devices and FET devices are all interchangeable with any mix of semiconductor device types having substantially similar characteristics enough to enable the intended function of the circuit disclosed in Claims 1, 2, 3, 4, 5 or 6.

[c11] A method, electrical circuit or apparatus according to Claims 1 or 2 where said third switching device is controlled by any means to substantially enable the transfer of energy from said negative power supply to said negative energy storage capacitor.

[c12] A circuit, power converter or motor drive comprising at least one bipolar voltage semiconductor drive circuit where the negative voltage potential used to power this drive circuit is derived from a second power source, at substantially disparate or varying common mode voltage potentials with respect to said bipolar voltage semiconductor drive circuit, and where said negative voltage potential is supplied from said second power source without the use of a transformer or inductor and without the use of transformer isolation, capacitive isolation or optical isolation between said second power source and said negative voltage potential.

[c13] A circuit, integrated circuit or circuit module intended, in part or whole, to function as part of a semiconductor drive circuit that substantially operates according to Claim 11.

[c14] A method, electrical circuit or apparatus according to Claims 1 through 12 where any said drive circuit includes an under-voltage lockout circuit or

provision that inhibits a semiconductor device from being driven "on" until the positive, negative or positive and negative voltage supplies for that drive are within a prescribed voltage range.